ibaPDA-Multistation

Measure and record synchronously with multiple ibaPDA systems

Manual

Issue 2.1

Measurement Systems for Industry and Energy

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2.1	02-2026	Editorial update, use case merge task	nm	8.0.0

Contents

1 About this documentation

This documentation describes the function and application of the software *ibaPDA-Multistation*.

1.1 Target group and previous knowledge

This documentation is aimed at qualified professionals who are familiar with handling electrical and electronic modules as well as communication and measurement technology. A person is regarded as professional if they are capable of assessing safety and recognizing possible consequences and risks on the basis of their specialist training, knowledge and experience and knowledge of the standard regulations.

1.2 Notations

In this manual, the following notations are used:

Action	Notation
Menu command	Menu *Logic diagram*
Calling the menu command	*Step 1 – Step 2 – Step 3 – Step x* Example: Select the menu *Logic diagram – Add – New function block*.
Keys	<Key name> Example: <Alt>; <F1>
Press the keys simultaneously	<Key name> + <Key name> Example: <Alt> + <Ctrl>
Buttons	<Key name> Example: <OK>; <Cancel>
Filenames, paths	`Filename`, `Path` Example: `Test.docx`

1.3 Used symbols

If safety instructions or other notes are used in this manual, they mean:

Danger!

The non-observance of this safety information may result in an imminent risk of death or severe injury!

Observe the specified measures.

Warning!

The non-observance of this safety information may result in a potential risk of death or severe injury!

Observe the specified measures.

Caution!

The non-observance of this safety information may result in a potential risk of injury or material damage!

Observe the specified measures.

Note

A note specifies special requirements or actions to be observed.

Tip

Tip or example as a helpful note or insider tip to make the work a little bit easier.

Other documentation

Reference to additional documentation or further reading.

2 About ibaPDA-Multistation

ibaPDA-Multistation is an extension of the *ibaPDA* functionality that enables sample-accurate, synchronuous measurement and recording across multiple *ibaPDA* computers. *ibaPDA-Multistation* is specifically designed for applications where the number of required measurement channels exceeds the capacity of a single system, or where spatially distributed but time-aligned measurements are required.

Typical applications include high-speed measurements with iba cards (e.g., *ibaFOB*) or interfaces with high sampling rates (e.g., IEC 61850-9-2) in energy transmission systems, large industrial plants, or geographically distributed installations that must be analyzed as a single, coherent system. If there are not enough slots or resources, additional *ibaPDA* computers can be installed and the inputs distributed across multiple systems. Methods such as NTP, PTP, DCF77, and others are supported for synchronization and time stamp sources.

The multistation operation ensures that all participating *ibaPDA* systems acquire and record the signals absolutely synchronously with a synchronization accuracy of less than one sample. Central trigger management enables the exchange of trigger events between systems in a multistation network and controls data recording synchronously.

The trigger signals are transmitted with high accuracy, so that a trigger on one *ibaPDA* system can simultaneously start or stop recording on all other *ibaPDA* systems. The duration of pre-trigger and post-trigger can be freely configured.

This function is particularly useful for geographically distributed, technically connected plants, such as energy transmission systems, enabling the detection of interactions and subsequent events.

During analysis in *ibaAnalyzer*, the data appears as if all signals were recorded by a single system. Wiring effort is reduced, as signals required by multiple *ibaPDA* systems need to be connected only once.

2.1 System requirements

The following system requirements are necessary for using *ibaPDA-Multistation*:

Hardware

- *ibaPDA* computer according to the currently valid minimum requirements
- *ibaFOB-D* input cards for the measurement signals in each participating computer
- For the multistation master computer:

  1 *ibaFOB-4i-Dexp* + 1 *ibaFOB-4o-D*

  The module *ibaFOB-4o-D* must be connected to the mirror mode socket (white socket on the card board).

  Alternatively, all types of the *ibaFOB-Dexp* card family can be used for multistation operation.

- For synchronized multistation slaves

  At least 1 free *ibaFOB-D* input channel for synchronization (not required for non-synchronized slaves)

Note

You can continue to use the *ibaFOB-4i-D*, *ibaFOB-io-D*, and *ibaFOB-2io-D* card variants with existing systems, but these are no longer in production.

Other documentation

Further information on system requirements can be found in the documentation for *ibaPDA* and *ibaFOB-D*.

Software

- *ibaPDA* v7.1.0 or higher
- Extension license for *ibaPDA-Multistation*

License information

Order no.	Product name	Description
30.001930	ibaPDA-Multistation	Extension license for *ibaPDA* to include the multistation operation function The license is required for each computer in the multistation network.

2.2 Functional principle

Multistation operation enables synchronous data acquisition across multiple *ibaPDA* systems and mutual control of data recording. Two modes are supported: synchronized and non-synchronized multistation operation. In a multistation configuration, one *ibaPDA* system is defined as the multistation master, while the remaining systems operate as synchronized or non-synchronized slaves. In synchronized operation, the master distributes a high-precision synchronization clock via FO connections and coordinates the start and stop of acquisition for synchronized slaves as well as trigger processing throughout the network.

This approach ensures the following:

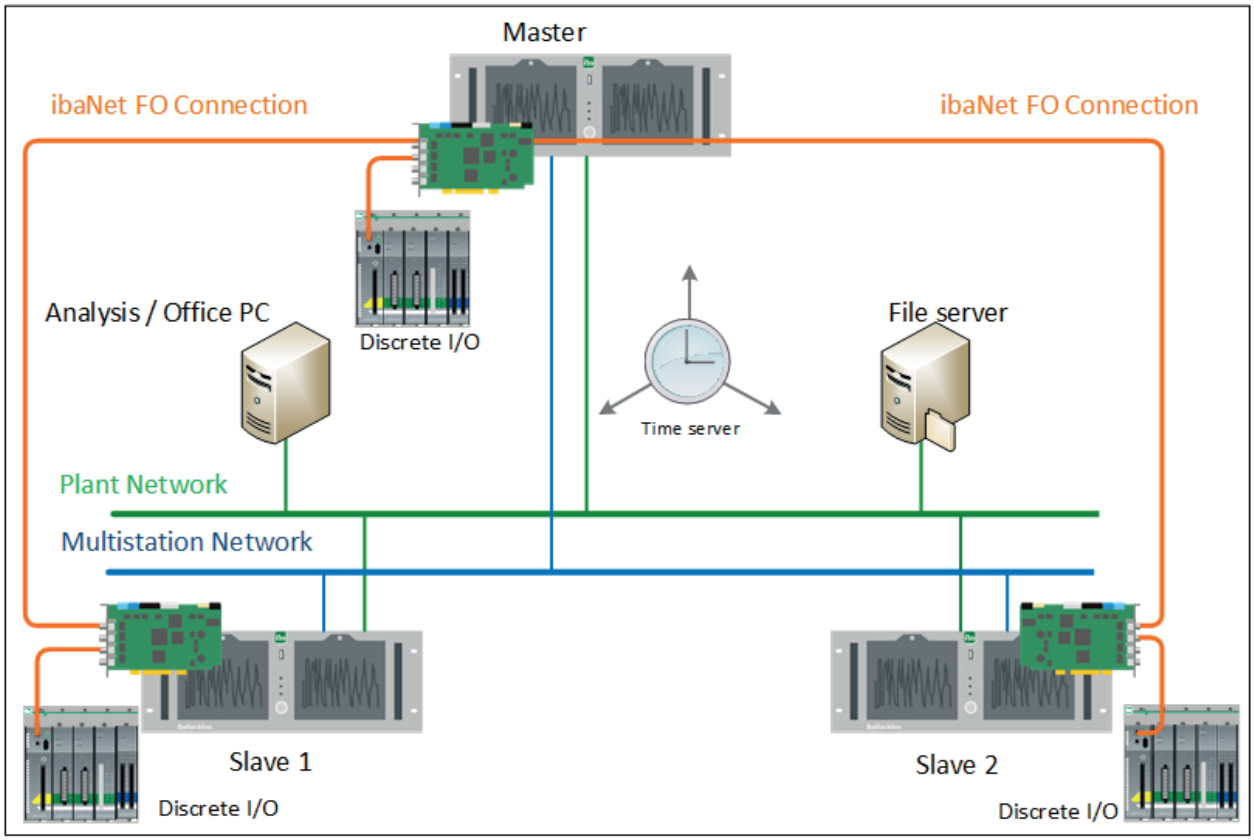
- All systems acquire data at exactly the same sample time (synchronized operation).
- Trigger events are globally consistent and have a precise time stamp.
- Recorded data files can later be analyzed as if they originated from a single system.

Mixed operation, combining synchronized and non-synchronized slaves within the same multistation network, is also supported.

Note

Typical configurations implemented to date consist of 3 to 5 *ibaPDA* systems. Due to technical limitations, a synchronized multistation network currently supports a maximum of 5 systems (1 master + 4 slaves).

The following image shows the participants in the synchronized multistation network, the connections between the systems, and the networks in which the systems are located.



Connections in the multistation network

Two types of connections are used in a multistation configuration:

- Network connection (multistation LAN) for the transmission of control signals (start/stop acquisition, watchdog, trigger, etc.)

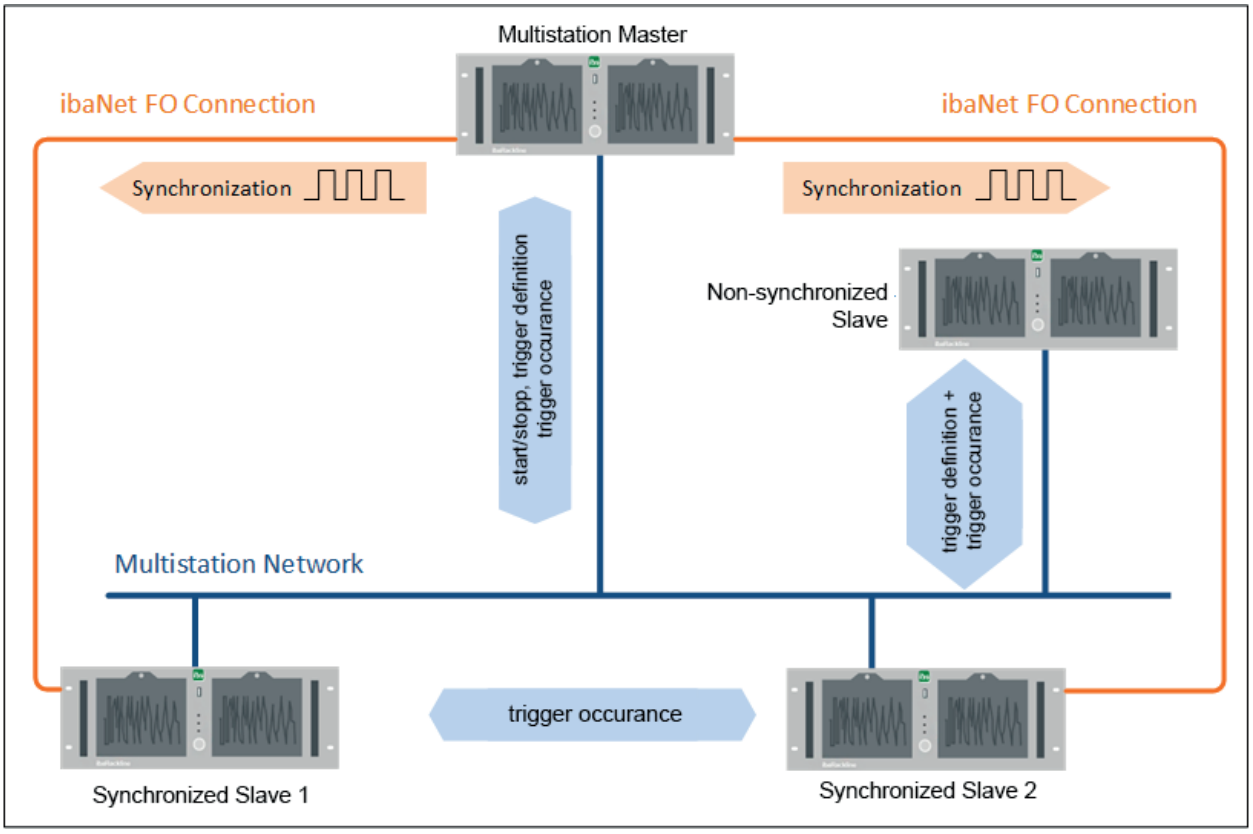
  This connection is established between all participants in a multistation network, as there are master, synchronized slaves and non-synchronized slaves, enabling communication between each other. The masters of different multistation networks can also be connected in this way.

- ibaNet fiber optic connection (FO) between *ibaFOB-D* cards for transmission of the synchronization clock

  This connection is only established between the master and synchronized slaves.

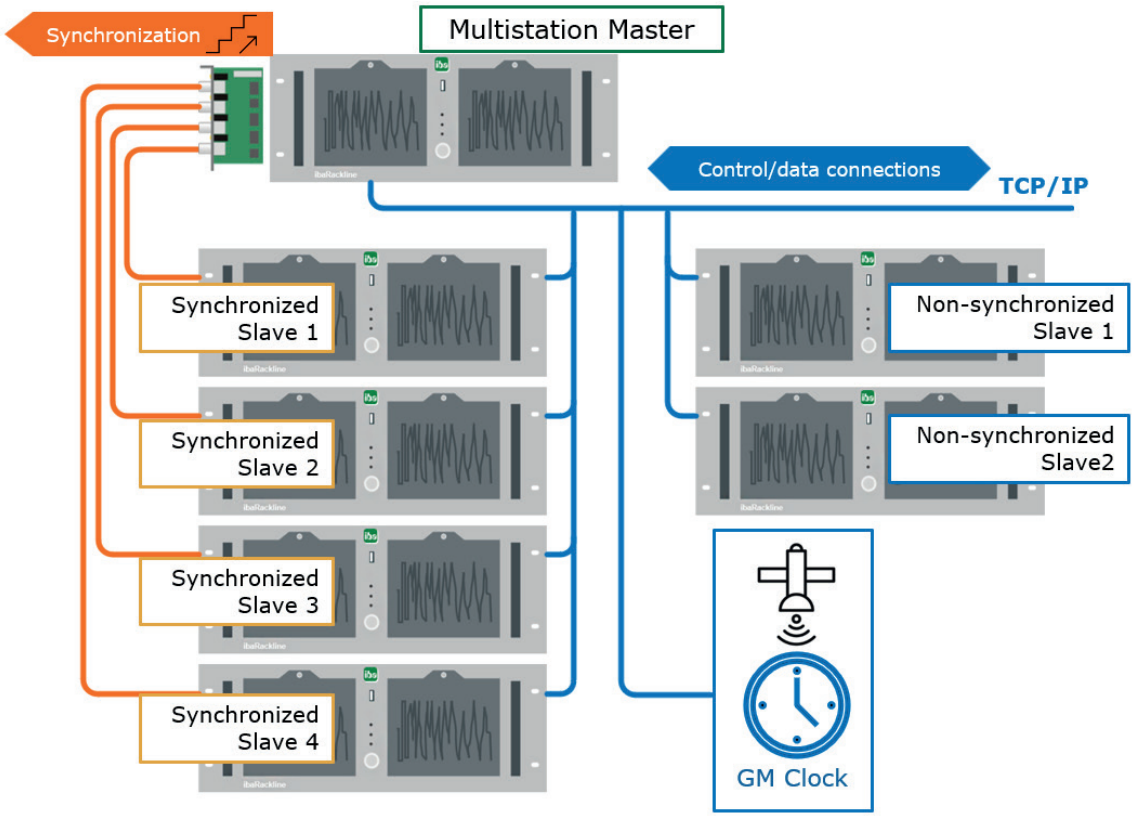
  With multiple slaves, a star topology is used, with the master at the center and connections to the slaves. Non-synchronized slaves are not connected in this topology.

The following image shows the basic connection types with the information transmitted in each case.



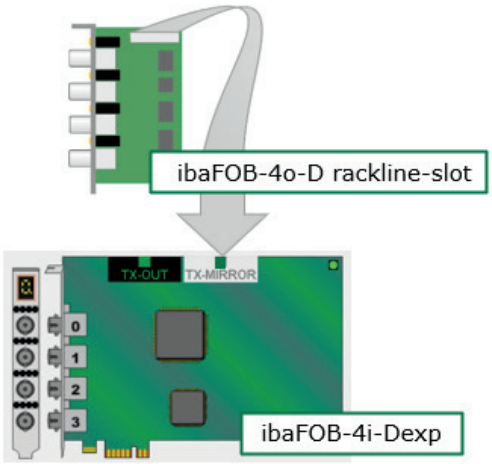
2.2.1 Connections in detail

Below you will find a description of the connections in the multistation network.



FO sync connection

The multistation master is connected to each synchronized slave via a fiber optic cable. The connection runs from an output of an *ibaFOB-4o-D* card in the master system to an input of an *ibaFOB-4i-Dexp* card in the synchronized slave.



The *ibaFOB-4o-D* module must be connected to the mirror socket of the *ibaFOB-4i-Dexp* card (white connector on the card). This *ibaFOB* card must be configured to *Interrupt mode* "Master mode internal".

The *ibaFOB* card in the synchronized slave must also be set to *Interrupt mod*e "Master mode internal", as it may provide the clock for additional cards within the computer.

The master transmits a clock signal via the fiber-optic connection, enabling all synchronized participants to sample measured values at exactly the same time. This clock is used to synchronize devices of the *ibaPADU-S* device family connected to the synchronized slaves.

ibaPDA compensates for protocol-related transmission delays, ensuring precise synchronization of signals transmitted via different fiber optic protocols and originating from different devices.

No fiber optic synchronization connection is required for non-synchronized slaves within a multistation network.

Ethernet connection

Besides the fiber optic synchronization connection, an Ethernet network is used between all systems. This establishes two different types of network connections:

- Control connections, with the the following functions:

  (synchronized slaves only)

  - Transmission of start and stop commands
  - Monitoring (watchdog)
  - Negotiation of the timing between the systems in the starting phase
  - Check for validation errors
  - Control of the precisely synchronized start of the acquisition
  - Ensuring synchronized data processing on all systems
  - Trigger configuration

- Data connections, with the the following functions:

  (all slaves)

  - Transmission of trigger events

In synchronized multistation operation, communication takes place via TCP/IP. For non-synchronized slaves, you can choose between UDP unicast and UDP multicast.

The control and data connections are established between the master and slaves during the start phase. If there is more than one slave in the network, a data connection is also established between the slaves so that each participant has a data connection to all other participants. Via the control connection, specific messages are exchanged between the slaves, which contain the system time of the master and furthermore information regarding the defined trigger events, which have been calculated based on the data volume to be processed.

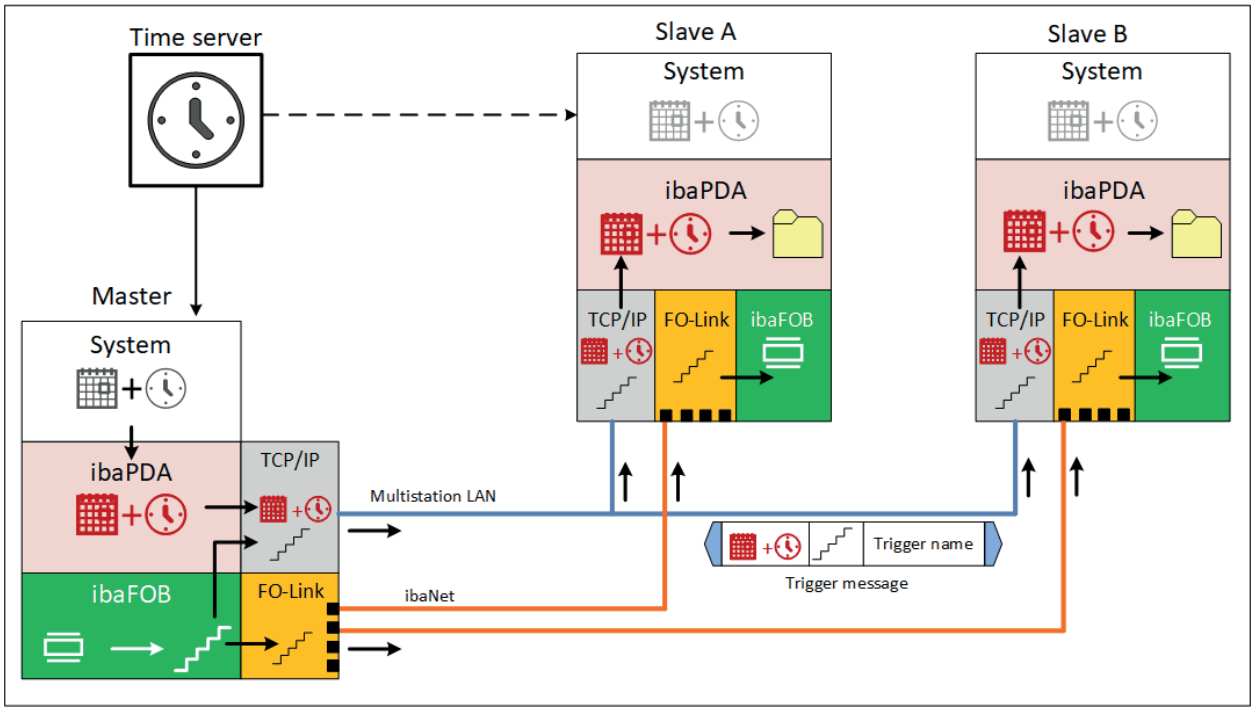
In synchronized operation, acquisition only starts when each participant has received a message from all other participants.

2.2.2 Timing and synchronization

In multistation operation, a basic distinction is made between synchronized and non-synchronized operation.

Synchronized multistation operation

In a multistation network, the master synchronizes all connected slaves via the ibaNet FO connection with regard to the acquisition. The following image shows the processes in synchronized operation schematically.



The multistation master specifies the date, time, and the highly accurate clock for all slaves. Ideally, all computers involved should be connected to an external, accurate time source such as a Grandmaster Clock (GMC) or an equivalent high-precision external time source in order to obtain a relatively accurate time even if the master fails. However, the respective system times are irrelevant with regard to synchronization of the acquisition on the individual slaves.

Only the date and time of the master are used for the acquisition and to time stamp the data files!

The *ibaFOB* card in the master generates a highly accurate clock signal in the nanosecond accuracy and feeds it into a counter value. This clock signal or running counter value is transmitted via the FO connection to the *ibaFOB* cards of the slaves in order to synchronize them.

Simultaneously, the counter value and the date and time from the master are distributed to the slaves via the FO synchronization connection. This synchronization mechanism sets the system time of each participating computer, ensuring a consistent time base for data acquisition across all systems.

When a trigger event occurs on one participant, a message containing the trigger name, time stamp, and counter value is sent because all participants share the same time base and counter values, the event can be accurately classified on all systems, even in the presence of transmission latency, for example over long distances.

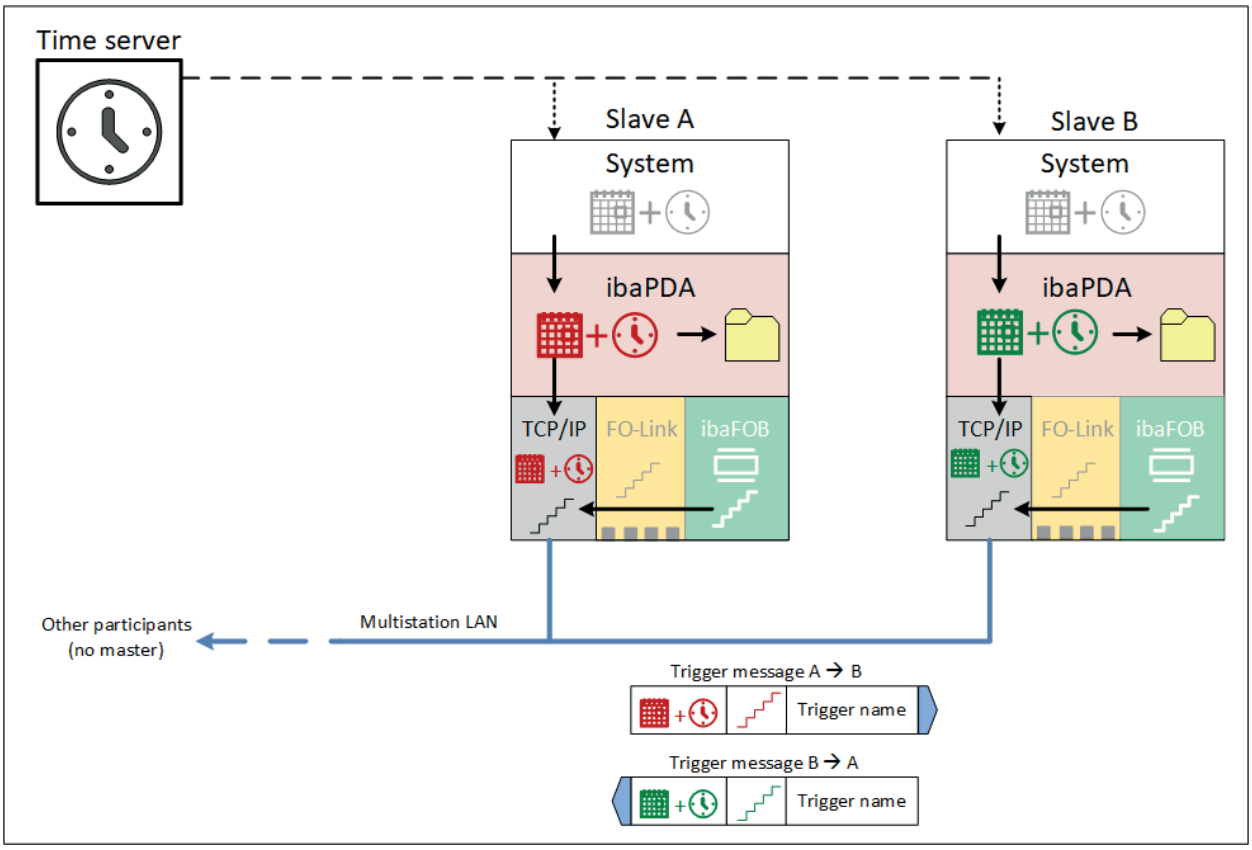
The receiving participants take the time stamp from the message to start the corresponding data file and select the samples according to the counter reading. The start time of the data file is the time of the trigger event, offset by a pre-trigger, if configured. Nevertheless, the time stamp of the trigger event is applied to the file name, if configured in the data store.

For illustration, see also the example in chapter ↗ *Trigger configuration, page 23*.

Non synchronized multistation operation

In non-synchronized operation, all computers operate as independent systems. There is no synchronization via an ibaNet FO connection and therefore no master-controlled acquisition. Each participant runs its data acquisition based on its own local clock. The only interaction between participants is the exchange of trigger information when a trigger event occurs.

The following image shows the processes in non-synchronized operation schematically.



Each non-synchronized participant must therefore be explicitly configured to exchange trigger events with every other participant it is intended to communicate with. Unlike synchronized operation, no central configuration or automatic distribution of trigger connections is possible. All trigger communication relationships must be defined individually.

Only the multistation LAN is available for communication. When a trigger event occurs, the relevant participant sends a message containing the trigger name, its own clock counter reading, and its own date and time.

The receiving participants take the time stamp from the message and assign it according to their own time in order to date the data file and select the appropriate samples. The start time of the data file is the time of the trigger event, offset by a pre-trigger, if configured. Nevertheless, the time stamp of the trigger event is applied to the file name, if configured in the data store.

Accurate time synchronization is critical in non-synchronized operation. Each participant must be connected to a Grandmaster Clock (GMC) or an equivalent high-precision external time source. The timestamp provided by this time source is used to assign and align recorded data during storage and later analysis.

Note

To avoid conflicts between Windows time management and *ibaPDA* time synchronization, also disable the local *Windows time* service.

Other documentation

Information on configuring time synchronization in *ibaPDA* can be found in the *ibaPDA* documentation, part 2 "I/O Manager."

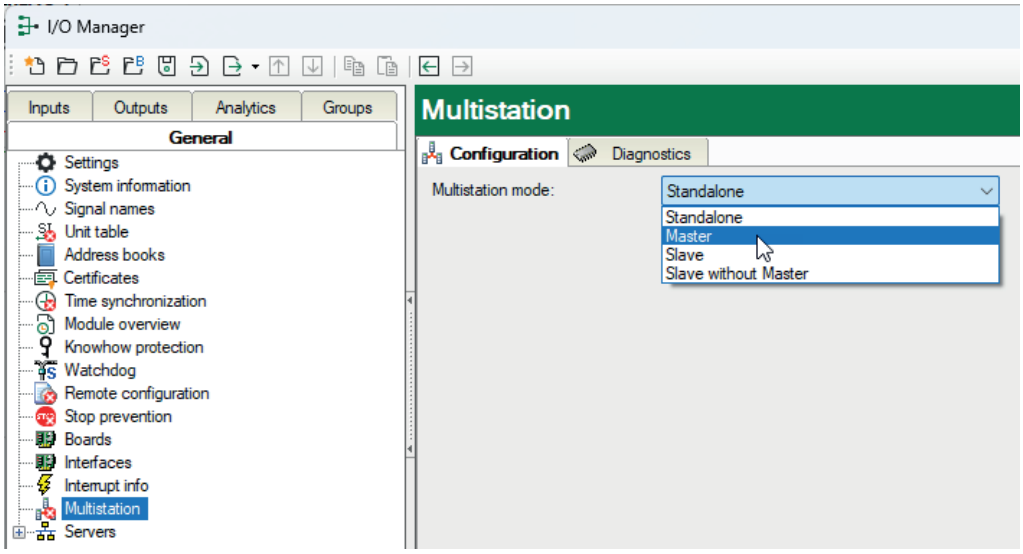
If a trigger event is received with significant delay and the corresponding data is no longer fully available in the receiving system's RAM, the receiving participant will still start a recording. In such cases, the resulting data file may miss samples at the beginning. However, the trigger event itself is documented and timestamped according to the trigger information received.

3 Configuration and engineering ibaPDA

In the following, the configuration and project planning of multistation operation in *ibaPDA* is described.

3.1 Multistation configuration

You can configure multistation operation in the *ibaPDA* I/O Manager in the *General* tab – *Multistation*.



Multistation mode

Mode	Meaning
Standalone (default)	Multistation operation is disabled, the *ibaPDA* system operates autonomously. In the interface tree this is indicated by the symbol.
Master	Select this mode on the *ibaPDA* system that is to operate as the multistation master. This computer must be equipped with FO hardware for distributing the synchronization clock (*ibaFOB* card with an *ibaFOB-4o-D* module at the mirror connection). This *ibaFOB* card must be set to *Interrupt mode* “Master mode internal”. In addition, the computer must be connected to the multistation LAN. See ↗ *Configuring the multistation master, page 18*.
Synchronized slave (Slave)	Select this mode on all *ibaPDA* systems that are to be synchronized by the master via ibaNet FO connection. Each slave requires an ibaNet FO connection to the master. To do this, an *ibaFOB* input card must be inserted in the computer and set to *Interrupt mode* “Master mode internal”. The FO connection from the output module of the master computer can be established to any free link on the card. In addition, the computer must be connected to the Ethernet network. See ↗ *Configuring a synchronized slave, page 20*.

Mode	Meaning
Non-synchronized slave (Slave without master)	Select this mode on an *ibaPDA* system that is to be connected to the multistation LAN in order to exchange global triggers, but otherwise collects its data independently. This system is not synchronized by the master and therefore does not require an ibaNet FO connection. A connection to the Ethernet network is still required. See ↗ *Configuring a non synchronized slave, page 21*.

The following matrix shows the connection options between systems with different and identical multistation modes.

Multistation mode	Standalone	Master	Synchronized slave (Slave)	Non-synchronized slave (Slave without Master)
Standalone	-	-	-	-
Master	-	***	**	*
Synchronized slave (Slave)	-	**	*	*
Non-synchronized slave (Slave without Master)	-	*	*	*

* connection only via Multistation LAN, only non-synchronized connections

** multistation network with FO synchronization and network, non-synchronized connections optional

*** master-master, only connection between two multistation networks, only non-synchronized connections

Port number
Port number of the current computer

The port is preset to 9175. The master and all synchronized slaves in the multistation network must use the same port number.

Start timeout (master only)
Time that the system waits until it has established a connection with the other participants before starting the measurement.

If the acquisition must be started on a slave, e.g. after a change of the I/O configuration, the system waits for a feedback of the master for this time. If the connection to the master is not achieved in this time, the systems starts in the standalone mode.

Non-synchronized systems (Unsynchronized stations)
(master and synchronized slaves only)

Selection of the protocol for communication with non-synchronized participants.

Receiving port/Port
(master and synchronized slaves only)

Port number for the exchange of multicast messages

The default port number for UDP unicast is 9177, and for UDP multicast it is 9176.

Local IP address (UDP multicast only)
Network card of the local *ibaPDA* server to be used for communication with non-synchronized participants

Multicast IP address (UDP multicast only)
IP address for the exchange of multicast messages

TTL (Time To Live)
Here you can set how many routers a multicast message can pass through. Ideally, TTL = 1, i.e., even the non-synchronized slaves are directly connected to the multistation LAN.

3.1.1 Basic configuration procedure

The following describes how to set up the multistation network. iba recommends proceeding step by step and expanding the network from the master by adding one slave at a time.

Prerequisite: The necessary network connections and ibaNet FO connections between the participants have been established.

1. First connect all *ibaPDA* systems that are to participate in the multistation network to an external, accurate time source (GMC or GPS clock).
2. Configure the required trigger modules and global triggers, see ↗ *Trigger configuration, page 23*.

   To ensure consistent trigger behavior across all participants, complete the global trigger configuration before starting multistation operation.
3. Define the master and perform the configuration, see ↗ *Configuring the multistation master, page 18*.

   Add the first synchronized slave in this step. Set the slave directly to the "Synchronized slave" (Slave) multistation mode.
4. Continue with the configuration of the added slave in its I/O Manager, see ↗ *Configuring a synchronized slave, page 20*.
5. Now add the second slave in the master's I/O Manager and assign it the multistation mode "Synchronized slave" (Slave) as well.
6. Continue with the configuration of the second slave in its I/O Manager. Please note that in addition to the connection to the master, the connection to the first synchronized slave must also be configured.

   Also add the connection to the second slave in the I/O Manager of the first slave.
7. Repeat the steps for each additional slave in the same way.

   Please note that all slaves must have a connection to the master as well as a connection to the other slaves in the multistation network.

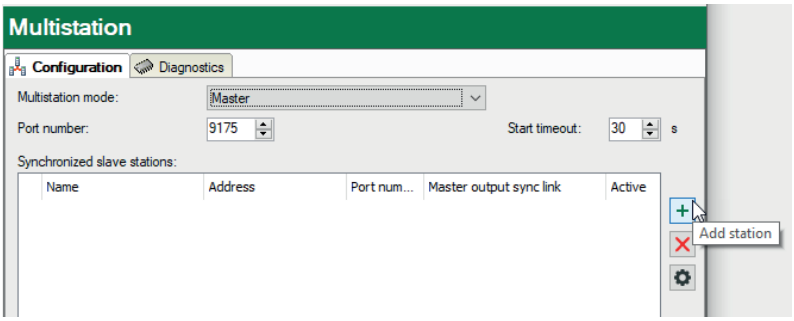
   If you also want to include non-synchronized slaves in the network, follow the steps in ↗ *Configuring a non synchronized slave, page 21*.

3.1.2 Configuring the multistation master

Proceed as follows to configure the master in the multistation network.

1. In the *Multistation mode* field, select the "Master" option.

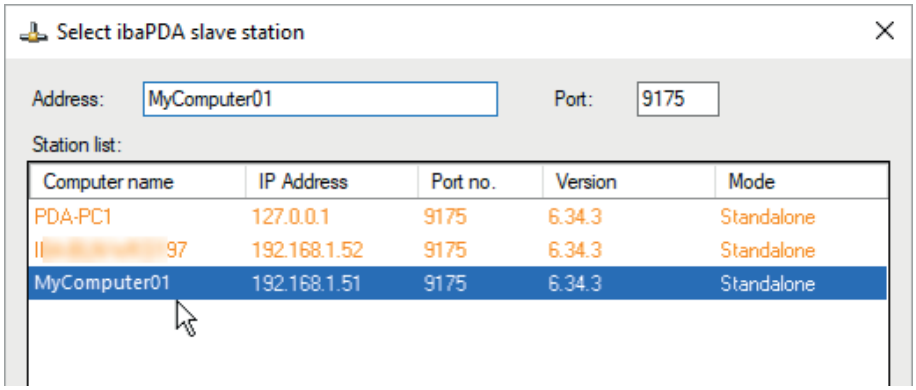
→ The dialog shows additional settings options, see ↗ *Multistation configuration, page 15*.



2. Add all participating *ibaPDA* systems under *Synchronized systems* (Synchronized slave stations).

   To do this, click on the button + .

→ A browser is opened, where all *ibaPDA* servers that are active in the network are listed.



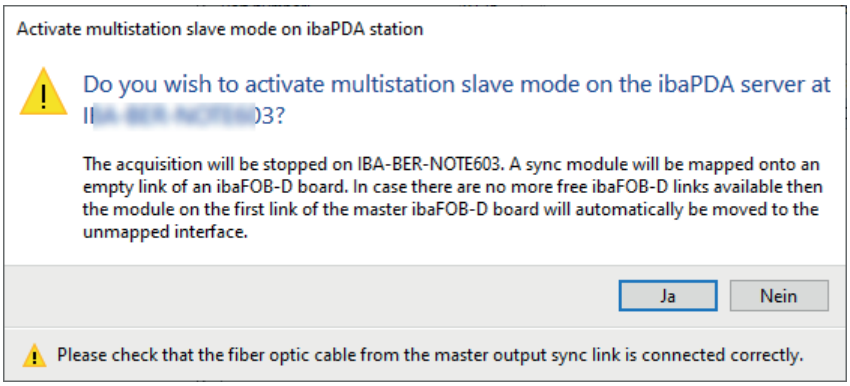
   In addition to the computer name, IP address, port number, and *ibaPDA* version, the current multistation mode of the *ibaPDA* systems is also displayed.

   The color of the lines has the following meaning:

   - Green: The system supports multistation operation and the computer is already in the “Synchronized slave” (Slave) mode.
   - Orange: The system supports multistation operation and the computer is not in the right mode (“Standalone” or “Non-synchronized slave”(“Slave without Master”).
   - Red: The system does not support multistation operation (software upgrade required).

3. Select a system that should be run as synchronized slave.

   If the system in question is in "Standalone" or "Non-synchronized slave" (Slave without Master) mode, a note appears asking whether the mode should be changed to "Synchronized slave” (Slave).



4. Confirm with <Yes>.

→ The acquisition on the slave is then stopped, the system is set to the "Synchronized slave" (Slave) multistation mode, and is then ready to be started together with the master system.

5. Optionally, assign a name for the connection to the synchronized slave.

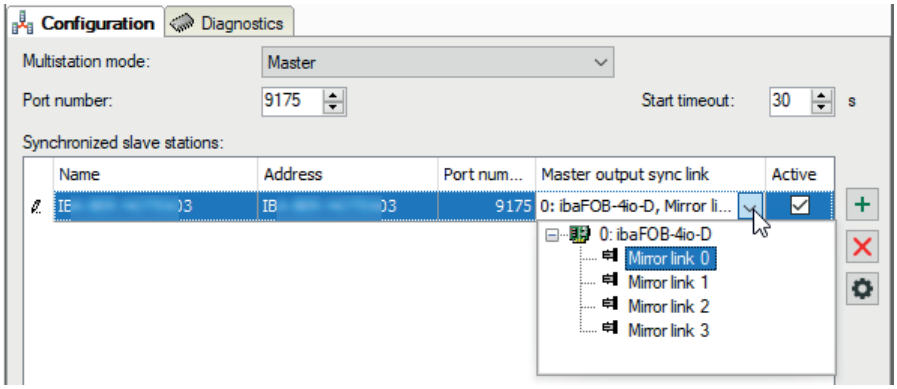
   The computer name is used by default.

6. Enter the IP address or computer name in the *Address* column if it has not been entered automatically.

7. Enter the port number in the corresponding column if it has not been entered automatically.

   Make sure, that all involved computers in the multistation network use the same port number.

8. Finally, select the link of an *ibaFOB-4o-D* output card (mirror module) of the master, which is connected to an input of the *ibaFOB-D* input card (interrupt master) in the relevant slave. The computer is synchronized via this link.



9. Perform the necessary steps to configure the added slave.

   See ↗ *Configuring a synchronized slave, page 20*.

10. Repeat steps 2 through 9 until all synchronized slaves are connected.

11. If non-synchronized slaves are to participate in the multistation network, enable support for these connections with the master. To do this, select the communication protocol under *Non-synchronized systems* (Unsynchronized stations).

    For further information on the differences between and application of UDP multicast and UDP unicast, see ↗ *Configuring a non synchronized slave, page 21*.

Note

Communication with non-synchronized slaves must also be configured if two multistation masters are to be connected in order to exchange trigger signals via the network ("interstation triggering").

3.1.3 Configuring a synchronized slave

Usually, each system can be configured as synchronized slave when configuring the multistation master, see ↗ *Configuring the multistation master, page 18*.

If you want to configure a system as a synchronized slave via its own I/O Manager, proceed as follows.

1. In the *Multistation mode* field, select the "Synchronized slave" (Slave) option.

→ The dialog shows additional settings options.

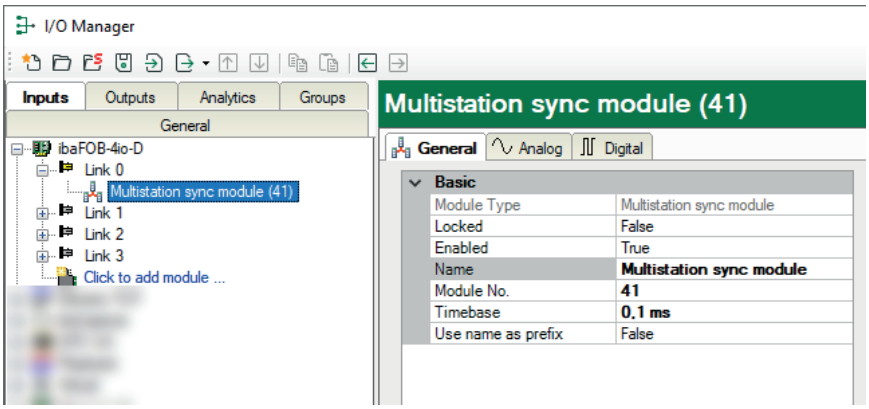
2. If necessary, adjust the port number and the value for the start timeout.

   The port number must be identical to the port number of the master (default 9175).

3. You can also configure support for non-synchronized slaves, see ↗ *Configuring a non synchronized slave, page 21*.

   The connection is always established from the master to the synchronized slave, so that the synchronized slave does not need to know the name or address of the master.

→ As soon as an *ibaPDA* system has been set to "Synchronized slave" mode, a "Multistation sync module" is automatically added to the I/O Manager of the relevant participant on the first free link of the *ibaFOB-D* card (Interrupt Master).



Like other modules, this module also has the *General*, *Analog* and *Digital* tabs. However, the settings and values are primarily intended for internal administration and debugging purposes. They have no practical use for the user.

Do not change the timebase setting, as this is already preset properly.

The module supplies two signals:

- Analog value “Sync counter”, a 24 bit counter of synchronization messages
- Digital signal “Clock”, a digital pulse signal running in 1 ms clock (interrupt)

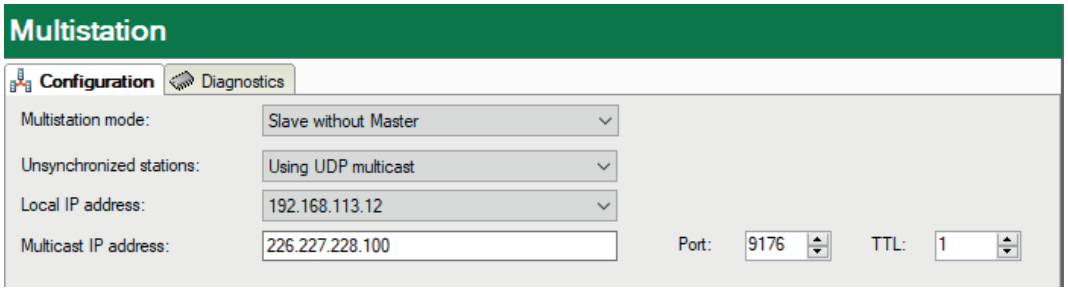
These signals are also available in the signal tree for display and in the signal selection of the data stores.

3.1.4 Configuring a non synchronized slave

ibaPDA systems configured as "non-synchronized slaves" (slave without master) can only be included in a multistation network if other participants (masters or synchronized slaves) support communication with non-synchronized slaves.

Information on configuration can be found in ↗ *Configuring the multistation master, page 18* and ↗ *Configuring a synchronized slave, page 20*.

Since a non-synchronized slave does not have an FO link for synchronization, only multistation mode and communication can be configured.



1. Under *Multistation mode*, select the option "Non-synchronized slave" (Slave without Master).
2. Under *Non-synchronized systems* (Unsynchronized stations), select the communication protocol to be used.

   You can choose between UDP multicast and UDP unicast.

   - Select UDP multicast if you want to include all participants in the network.
   - Select UDP unicast if you only want to reach specific participants.
3. If you are using UDP unicast, follow the steps unter ↗ *Configuring communication via UDP unicast, page 22*.
4. If you are using UDP multicast follow the steps under ↗ *Configuring communication via UDP multicast, page 21*.

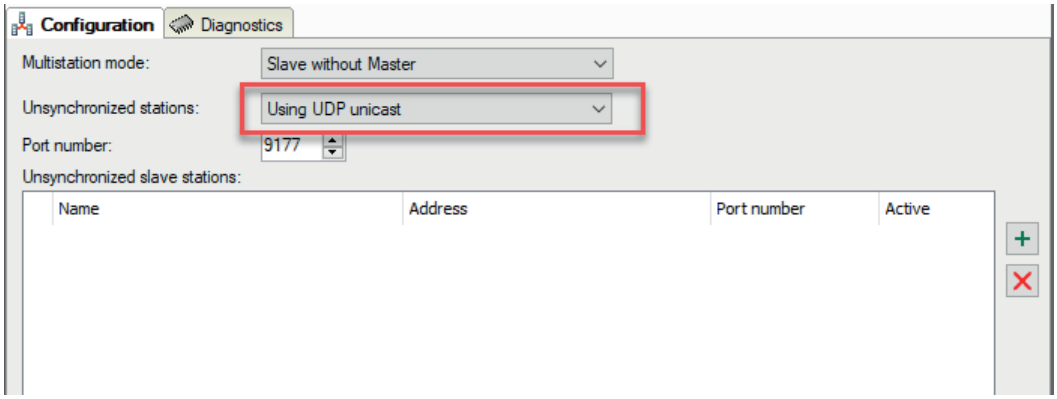
Configuring communication via UDP multicast

1. First, in the *Local IP address* field, select the network card in the local *ibaPDA* server that is to be used for communication with non-synchronized slaves.

   Make your selection based on the IP address in the selection list, which contains all configured IP addresses of the *ibaPDA* server.
2. If necessary, set the Multicast IP address and port number that the stations should use for exchanging multicast messages.

   All participants in the multistation network must use the same port number.
3. With the *TTL* (Time To Live) parameter you can define how many routers a multicast message can pass through. Ideally, TTL = 1, i.e., even the non-synchronized slaves are directly connected to the multistation LAN.

Configuring communication via UDP unicast



1. If necessary, change the port number for UDP unicast.

   The port number is preset to 9177.

2. In the *Non-synchronized systens* (Unsynchronized slave stations) table, you can add the desired participants with which the local system should communicate.

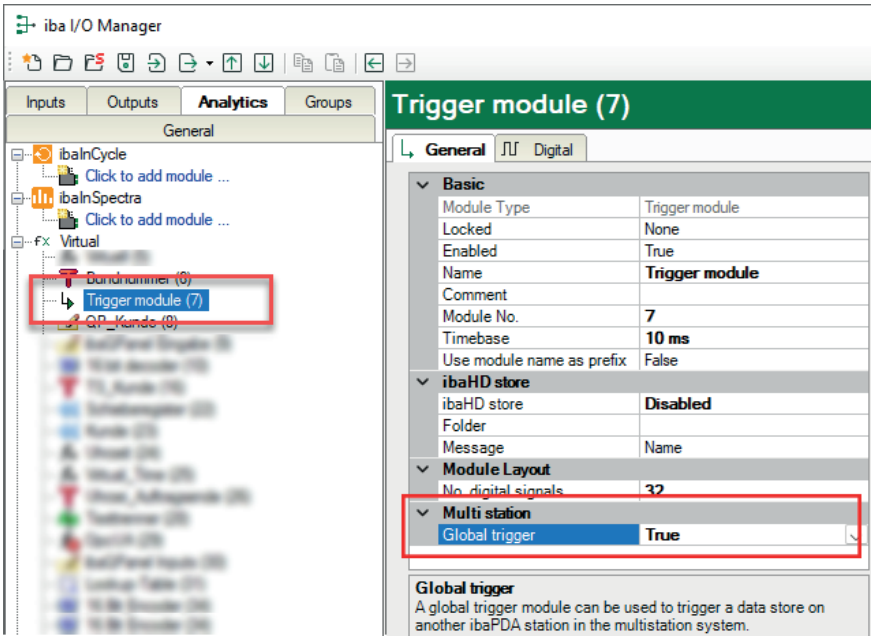
   These can be non-synchronized slaves or *ibaPDA* systems for which communication with non-synchronized slaves via UDP unicast has been activated.

3.2 Trigger configuration

In a multistation network, a trigger from one participant can be used to start or stop data recording on another participant. For this purpose there are “global triggers”. Global trigger is a property of the trigger modules, which can be enabled or disabled in the general module settings. If this property is set to *True*, all trigger signals in this module are considered global triggers and can be used to control data recording at another participant.

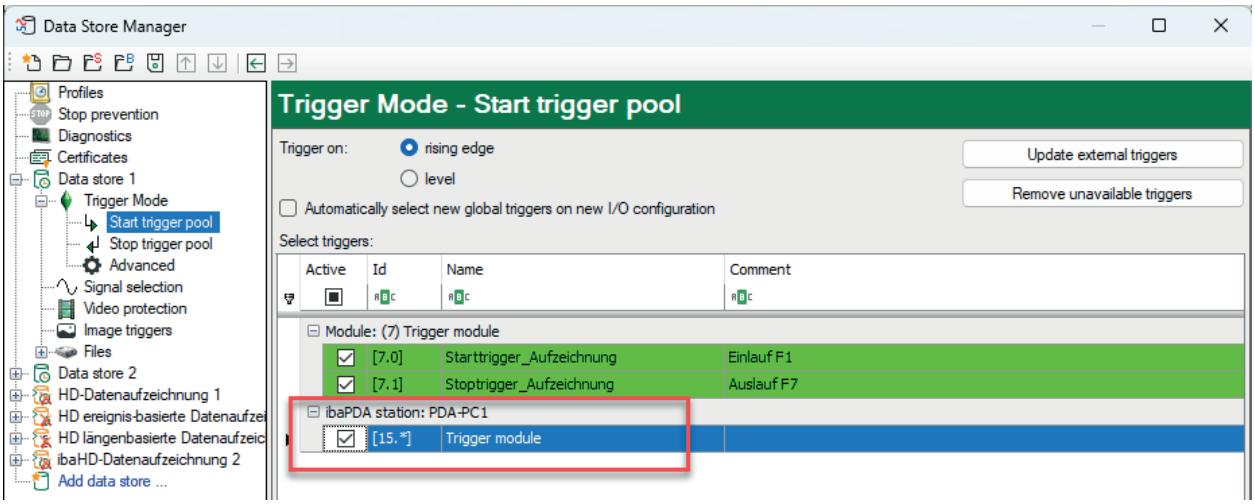
Other documentation

Detailed information on the trigger pool function and trigger modules can be found in the *ibaPDA* documentation, part 3 "Data Interfaces and Modules."



The global trigger module is then available in the data store configuration of all other participants in the multistation network and can only be activated in the start or stop trigger pool.

The global trigger module is listed with one line and an indication of the original system in the trigger pool. It can only be enabled entirely, the access to particular global trigger signals is not possible. In terms of a logical OR operation, a trigger is activated when one of the global trigger signals (in the source) triggers.



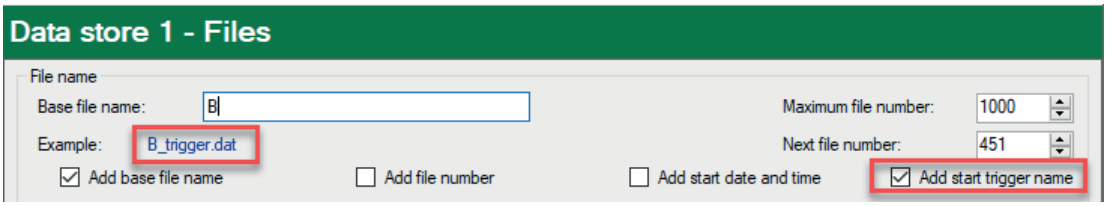
When a global trigger is activated, the station concerned sends a message via the data connections (network) to all other systems. This message contains the following information, among other things:

- Name of the trigger event
- Trigger condition
- Name of the multistation participant where the trigger occurred
- Precise time stamp
- Synchronized sample counter (for synchronized operation)

Transferring the sample number ensures that the trigger event is inserted at the same sample position in all recorded data files. Since all systems count the samples in perfect synchronization, this ensures precise alignment. Only by different pre- and post-trigger times at the store configuration, different intervals, e.g. from the starting point of the data file to the trigger event, can be present in the data file.

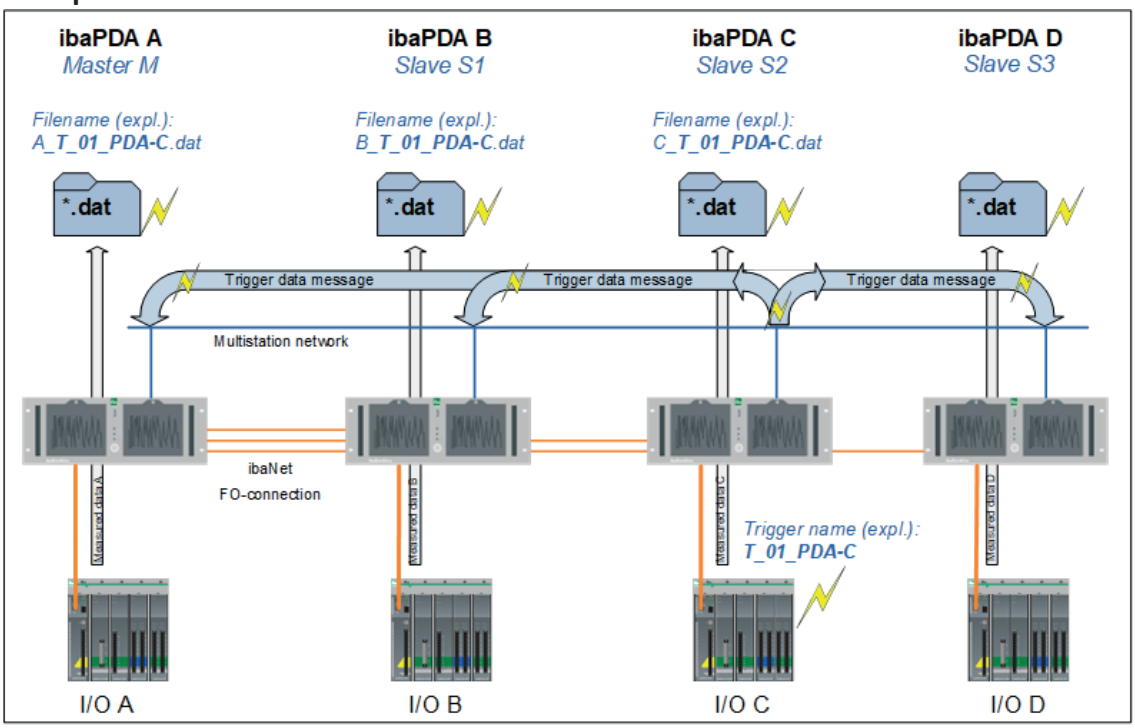
The transmission of the trigger name provides for the information which event activated the trigger. Since the trigger name can be used to create the data file name, data files can be generated that can be clearly assigned to a trigger event.

To include the trigger name into the file name you must enable the “Add trigger name” option in the configuration dialog of the data store under *Files*.



This option is only available if "Use start trigger pool" or "Use stop trigger pool" has been selected as the trigger type in the trigger settings for the store.

Example



The image shows a configuration consisting of 4 *ibaPDA* systems

In the “ibaPDA C” system, a trigger named T_01_PDA-C is defined, that belongs to the group of global triggers. When the trigger in the “ibaPDA C” system occurs, a message comprising the trigger event is sent to all of the other participants in the multistation network via the data connection.

If data stores are configured in other systems with the global trigger e.g. in the start trigger pool, recordings are started there at the same time. When recordings are started or stopped by a trigger pool, the triggering events are written to the measurement file as info fields. The following info fields for a start trigger can be found in the info node of the data file:

- “start_event”, followed by the signal and/or trigger name
- “start_event_expression”, followed by an expression which evaluates the signal

Accordingly, the info fields “stop_event” and “stop_event_expression” exist for the stop trigger. To ensure that the generated data files can be easily linked to the trigger event, the "Add trigger name" option was selected in the data store configuration on all systems. The data files for the individual systems then have the trigger name T_01_PDA-C in their file names.

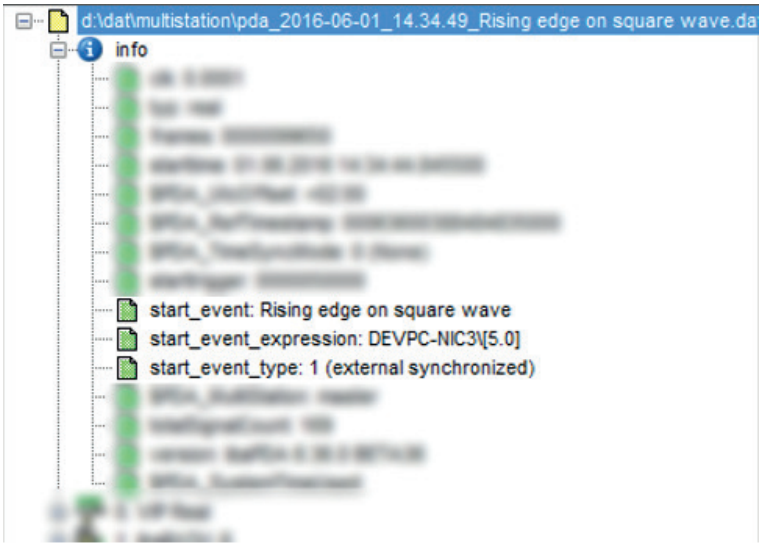
In order to be able to identify the data files later in *ibaAnalyzer*, the file names begin with the name of the respective *ibaPDA* system, as in this example B_T-01_PDA-C.dat for system “B”.

In addition, the info fields "start_event_type" for start triggers and "stop_event_type" for stop triggers are added to the data files. These info fields indicate which trigger type triggered the respective data file. The info fields can have the following values:

Value	Meaning
0 (local)	This is a local trigger.
1 (external synchronized)	This is a synchronized external trigger.
2 (external synchronized)	This is an unsynchronized external trigger whose time stamp could be synchronized with the local data.
3 (external unsynchronized invalid time)	This is an unsynchronized external trigger whose time stamp deviated by more than 5 seconds from the current UTC time when it was received. A data file was generated, but the trigger time stamp was changed to the current UTC system time.

Displaying information in ibaAnalyzer

The following image shows an open data file with info fields for the start trigger with name, expression, and type.



3.2.1 Trigger for non-synchronized participants

Global triggers from non-synchronized slaves are marked in the start and stop trigger pool of the data recording configuration of the other participants with the addition "Non-synchronized slave..." in the group header.

Unlike synchronized slaves, trigger configurations on non-synchronized participants are not automatically updated when acquisition is started. You must manually click the <Update external triggers> button in the data store configuration so that *ibaPDA* searches for non-synchronized slaves and updates the trigger definitions.

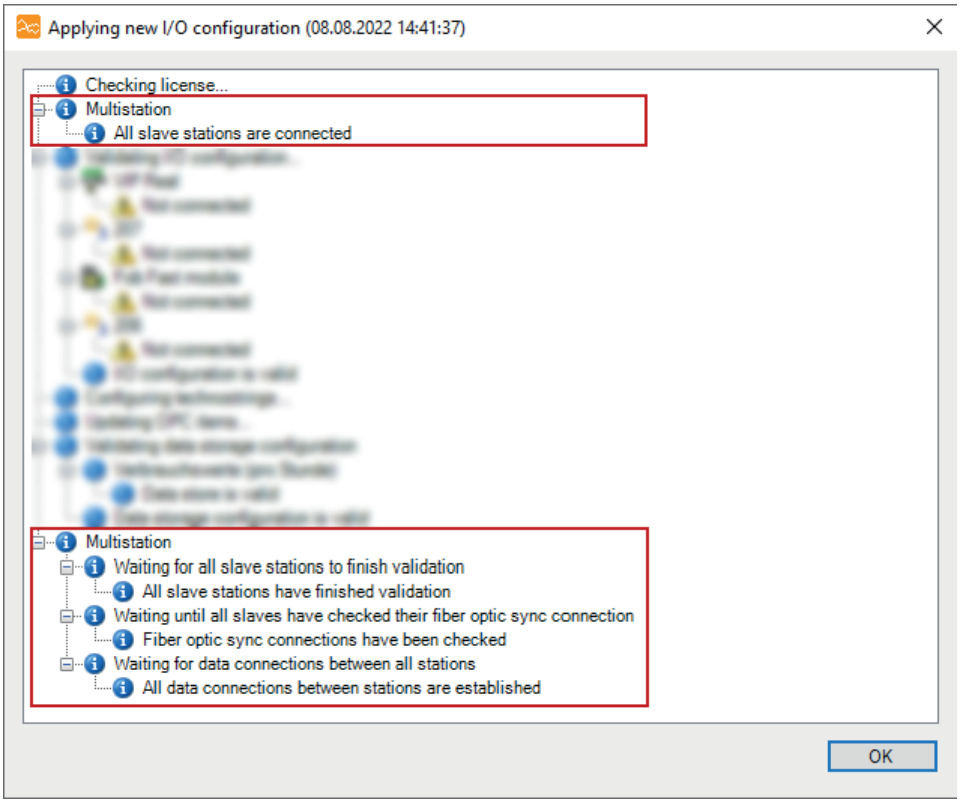
When a trigger is activated on a system where support for non-synchronized slaves is enabled, the trigger event is sent via the multicast address so that all other stations can receive the event. If the transmission type is set to UDP unicast, the trigger event is sent to the configured systems accordingly.

The event message contains the trigger name, the ID (module and signal number), and the absolute UTC time at which the trigger event occurred.

Non-synchronized slaves that receive such an event compare the received absolute UTC time with their own UTC system time in order to synchronize the trigger event with their own acquired data. To do this, it is very important that the system time of all non-synchronized slaves is accurate. The more accurate the system time, the more precisely the trigger event can be synchronized with the local data.

4 Multistation operation

4.1 Start of the acquisition



In a multistation network, the acquisition is started and stopped synchronously on all participants. When the acquisition is started on any system (master or slaves), it starts at the same time on all other participants in the network. The same applies to stopping the acquisition.

The following cases are differentiated:

Starting the acquisition on the multistation master
If the acquisition is started on the master, it first establishes connections to the slaves. If a slave cannot be connected within the set start timeout period, the slave will be disabled. The acquisition then starts on the master and all connected slaves. If no slave can be connected, the master starts in standalone mode.

Starting the acquisition on a synchronized slave
If the acquisition is started on a synchronized slave, it waits until a connection to the master is established. If this does not succeed within the set start timeout period, the slave starts in standalone mode.

Starting the acquisition in case of configuration error
If validation after the start of acquisition reveals that the configuration of a computer is invalid, it is excluded from the multistation network.

- The affected computer is the master: All other slaves start in standalone mode.
- The affected computer is a synchronized slave: As soon as the computer is available, it will be reintegrated into the multistation network.
- The affected computer is a non-synchronized slave: The computer remains excluded from the network until the next acquisition starts.

4.2 Dealing with connection problems

Multiple scenarios are possible during the operation of a multistation network. Here follows a description of the system behavior in some typical situations:

- **Master fails**

  If the master fails, central time synchronization for the connected slaves is lost. In this case, the synchronized slaves switch to standalone operation, restart the acquisition, and continue working independently using their local system time for data files. Since the system clocks of the computers typically do not drift significantly over short periods, or are synchronized via a Grandmaster Clock or GPS clock, any time deviations are initially minimal.

  As soon as the master becomes available again, all systems automatically restart and multistation operation is re-established.

- **Slave fails**

  If the connection to a slave is interrupted during acquisition, the acquisition is stopped and, after a timeout of 5 seconds, restarted with the remaining synchronized slaves. Once the affected slave becomes available again, the master stops the acquisition and all participants restart synchronously, restoring full multistation operation.

- **Fiber optic connection interrupted**

  If a synchronized slave was unable to start in multistation mode because the FO connection was interrupted at the start of the acquisition, it switches to "Standalone" mode and continuously monitors the FO connection. As soon as the FO connection is re-established and has been active for more than 2 seconds, the synchronized slave automatically restarts the acquisition and is included into the multistation network again.

- **Time synchronization (Grandmaster Clock) fails**

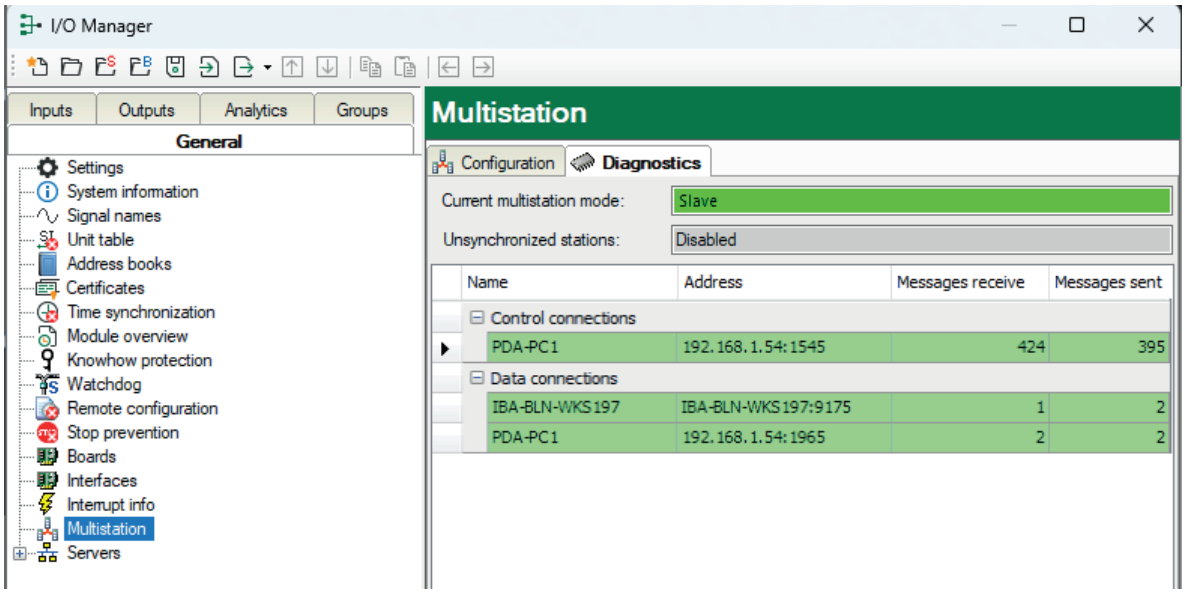
  If the Grandmaster Clock is unavailable, *ibaPDA* waits until the clock is available again. The time is kept by the motherboard's quartz, but this does not guarantee accuracy. The entire system shifts in time but remains internally synchronized. As soon as the Grandmaster Clock is available again, *ibaPDA* will synchronize itself.

5 Diagnostics

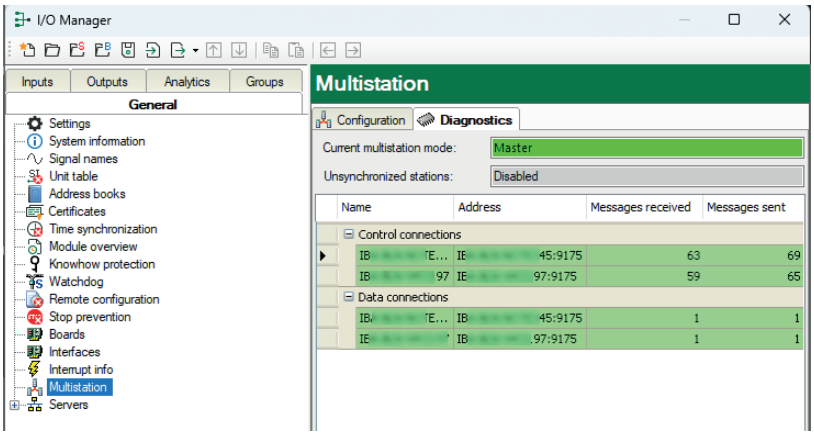
5.1 Diagnostics tab

The *Diagnostics* tab of the multistation node in the I/O Manager provides information about the connections between the individual participants.

Diagnostics on multistation master:



Diagnostics on synchronized slave:



Current multistation mode
This shows which mode the participant is in. Possible options are "Master," "Synchronized slave" (Slave), "Non-synchronized slave" (Slave without Master) or "Standalone."

Table
In the table, the network connections between the slaves (control and data connections) are displayed.

The example in both images above shows a system, consisting of 3 stations. The master has a control and data connection each to both synchronized slaves. The synchronized slave has a

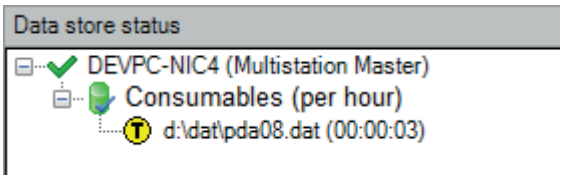
control connection to the master as well as a data connection to the master and to the other synchronized slave.

Connections with non-synchronized slaves are listed in a separate group called *Unsynchronized connections*, if configured. The background color of the lines with non-synchronized connections has the following meaning:

- Green: Trigger events are actively exchanged via this connection.
- Orange: No trigger events are exchanged via this connection because, for example, there is already a data connection to the same participant or because the trigger pools in the other participants' data store are not configured to respond to triggers from the local system.

5.2 Data store status

You can also see the current multistation mode of a participant in the window *Data store status*.



5.3 MultiStationStatus() function

In the expression builder there is a function MultiStationStatus() which detects and returns the current multistation mode.

Possible return values are:

0	Standalone
1	Synchronized slave
2	Master
3	Non-synchronized slave

This allows you to generate a virtual signal, for example, to visualize the status in *ibaQPanel* or to make it available to other systems as an output signal.

Other documentation

For more information on the expression builder and the use of virtual signals, refer to the *ibaPDA* documentation, Part 4 "Expression builder".

6 Application examples and FAQ

Here you will find useful application examples and answers to frequently asked questions about the *ibaPDA-Multistation*.

6.1 Using the merge task for multistation

Since all synchronized data files share identical start times, they can be automatically merged using *ibaDatCoordinator*. The merge task allows you to create a single consolidated data file per event, even when the recording is distributed across multiple computers. The merged file provides a quick and comprehensive overview of the event and enables automated post-processing based on predefined analysis rules. Automated reporting workflows are also built on this concept.

Other documentation

Further information on *ibaDatCoordinator*, the merge task, and an application example for multistation can be found in the *ibaDatCoordinator* documentation in the download area of the iba website or in the iba help portal at https://docs.iba-ag.com.

7 Support and contact

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Note

If you need support for software products, please state the number of the license container. For hardware products, please have the serial number of the device ready.

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